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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/708,281	02/22/2004	Roman Chistyakov	ZON-016	2280

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EXAMINER	
LIE, ANGELA M	

ART UNIT	PAPER NUMBER
2821	

DATE MAILED: 12/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

H·A

Office Action Summary	Application No.	Applicant(s)	
	10/708,281	CHISTYAKOV, ROMAN	
	Examiner	**Art Unit**	
	Angela M. Lie	2821	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 November 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-47* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9,11-13,16-31,34-36,38-45 and 47* is/are rejected.

7)☒ Claim(s) *10,14,15,32,33,37 and 46* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *22 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/29/2005,11/17/20*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

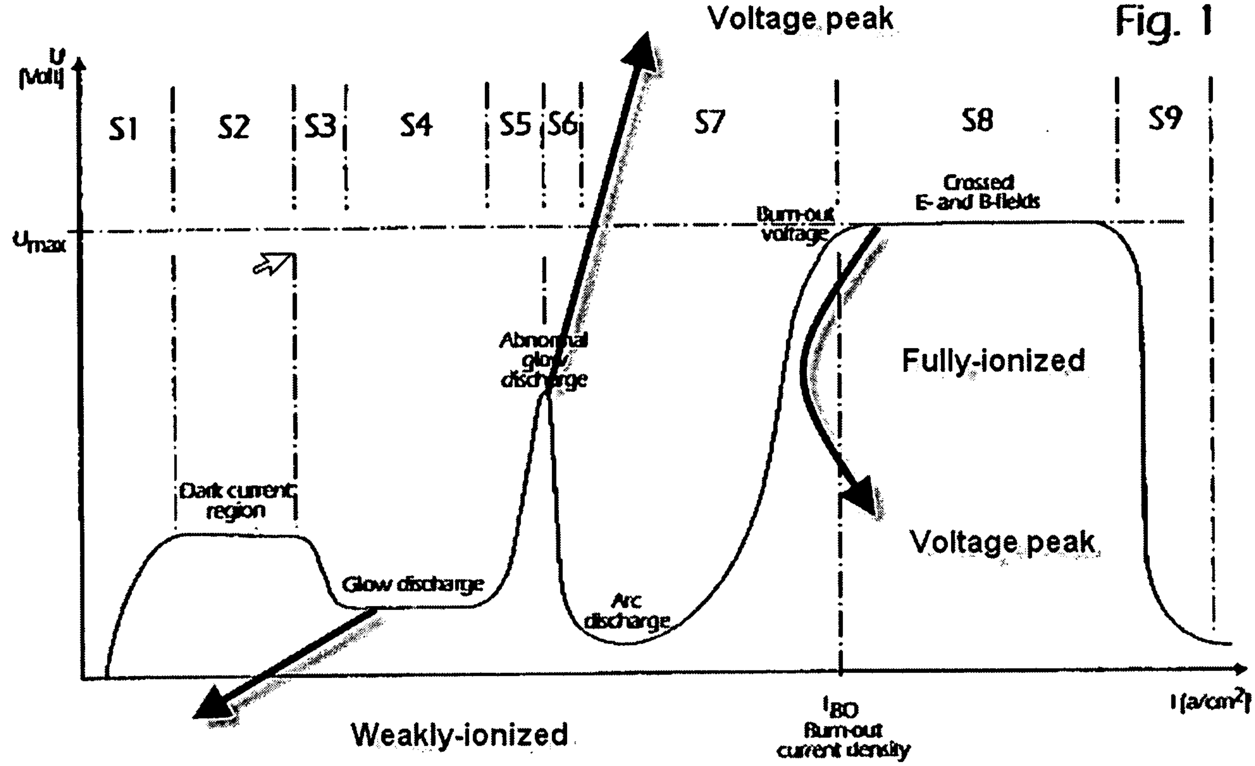
> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-5,7-9,11-13,16-22,24-28,31,34-36,38,39,41-45 and 47 are rejected under 35 U.S.C. 102(b) as being anticipated by Kouznetsov (US Patent 6296742).

As to claims 1 and 21, Kouznetsov discloses a strongly-ionized plasma generator and a method of generating a strongly-ionized plasma comprising: a chamber for confining a feed gas (Figure 2, element 1); an anode that is positioned inside the chamber (Figure 2, element 5, wherein inner part of the anode is inside the chamber); a cathode assembly (Figure 2, element 9) that is positioned adjacent to the anode inside the chamber; a pulsed power supply (Figure 2, element 18) having an output that is electrically connected between the anode (5) and the cathode assembly (9), the pulsed power supply generating at the output a multi-stage voltage pulse comprising: a low-power stage including a first peak voltage (as indicated in Figure 1 below) having a magnitude and a rise time that is sufficient to generate a weakly-ionized plasma from the feed gas; and a transient stage including a second peak voltage (as indicated in Figure 1 below) having a magnitude and a rise time that is sufficient to shift an electron energy distribution in the weakly-ionized plasma to higher energies that increase an

ionization rate which results in a rapid increase in electron density and formation of a strongly-ionized plasma.

Fig. 1



As to claim 3, Kouznetsov discloses the plasma generator wherein the magnet is movable (Figure 2, element 17, since magnet is a part of assembly, and it is a separate component, it is capable of being moved).

As to claim 4, Kouznetsov discloses the plasma generator wherein the magnetic field generated by the magnet confines the weakly-ionized and strongly ionized plasmas proximate to the cathode assembly (column 1, lines 58-66).

As to claim 7, Kouznetsov discloses the plasma generator wherein the magnitude of the first peak voltage is less than 1000 V (column 5, lines 42-44, if the

voltage at the stage of strongly ionized (second peak) can be around few hundreds of volts, then the first peak also can be below 1000 V).

As to claim 8, Kouznetsov discloses the plasma generator wherein the pulsed power supply provides enough energy for the electron energy distribution in the weakly-ionized plasma to continuously shift to higher energies until the strongly ionized plasma is formed (as shown in Figure 8, if supplied energy would not be enough to shift distribution from weakly-ionized plasma to strongly-ionized plasma, fully ionized state would not occur).

As to claim 9, Kouznetsov discloses the plasma generator further comprising an energy storage device (Figure 6, element C1) that is electrically coupled to the cathode assembly (as shown in figure 6), the energy storage device discharging energy into the weakly-ionized plasma to enhance the rapid increase in electron density and the formation of the strongly-ionized plasma (since C1 is electrically connected to the cathode and anode, once it discharges it will create an electric field between those two electrodes and that field is used to ionize plasma particles).

As to claim 11, Kouznetsov discloses a plasma generator wherein the pulsed power supply generates the transient stage (Figure 1, stages S5, S6 and S7) of the multi-stage pulse at a time that is at least 150 microseconds after the generation of the weakly-ionized plasma (Figure 1, S4; column 10, lines 47-49, wherein the total length of the pulse can be in range of about 50 microseconds to few hundreds, therefore 150 microseconds are included in this range).

As to claims 12 and 35, Kouznetsov discloses a plasma generator wherein the rise time of the second peak voltage in the transient stage is greater than about 0.5V/microsecond (Figure 1, and column 10, lines 32-34; since voltage is rising up to 2kV in the interval of 4 microseconds, and as shown in the figure 1, the potential difference between the second peak and the first peak is approximately 1/3 of the potential of the second peak, therefore once the voltage difference is taken and divided by the 4 microseconds, one can see that the transient stage is indeed greater than 0.5 V/usec).

As to claim 13, Kouznetsov discloses a plasma generator wherein the magnitude of the second peak voltage is less than about 1000 V over the first peak voltage (column 5, lines 42-44).

As to claim 16, Kouznetsov discloses a plasma generator wherein a discharge current density of the strongly-ionized plasma is greater than about 0.5A/cm^2 (column 3, lines 64-67, and column 5, lines 42-44; since maximum power can be up to 1 MW and maximum voltage at the stage of strongly ionized plasma can be 5kV, therefore 1MW/5kV = 200 A, furthermore this can be divided by the size of the chamber, in order to have current density of about 0.5 A/cm^2 we could have the area of chamber to be approximately 400 cm^2. Even though Kouznetsov does not explicitly state how big is chamber in his invention, in order to have a reasonable size it would have to be in the range below 400 cm^2, therefore the current density would be greater than about 0.5A/cm^2).

As to claim 17, Kouznetsov discloses a plasma generator wherein the power density of the strongly-ionized plasma is greater than 250W/cm^2 (column 3, lines 64-67; since power of each pulse is in range 0.1 kW to 1MW, and as shown in figure 1, fully ionized plasma has the highest potential peak, so strongly-ionized plasma has current density greater than 250W/cm^2. Also as mentioned above in the justification for rejecting claim 16, the size of the chamber should not exceed 400 cm^2).

As to claim 18, Kouznetsov discloses a plasma generator wherein the multi-stage voltage pulse further comprises a high-power stage (Figure 1, S8) following the transient stage, the high-power stage having a voltage that is sufficient to sustain the strongly-ionized plasma (As shown in figure 1 plasma is sustained for the period of S8).

As to claim 19, Kouznetsov discloses a plasma generator wherein the voltage in the high-power stage comprises a relatively constant average voltage (Figure 1, S8).

As to claim 20, Kouznetsov discloses a plasma generator wherein a lifetime of the strongly-ionized plasma is greater than about 200 microseconds (column 10, lines 47-49).

As to claim 25, Kouznetsov discloses the method wherein the first and the second voltages comprise a multi-stage voltage pulse (as shown in Figure 1 above).

As to claim 26, Kouznetsov discloses the method further comprising applying a third voltage between the anode and the cathode assembly that sustains the strongly-ionized plasma (Figure 1, Umax or S8).

As to claim 27, Kouznetsov discloses the method wherein an average value of the third voltage applied between the anode and the cathode assembly is relatively constant (as shown in figure 1, stage S8).

As to claim 28, Kouznetsov discloses the method wherein a lifetime of the strongly-ionized plasma is greater than 200 microseconds (column 10, lines 47-49).

As to claim 31, Kouznetsov discloses a method further comprising discharging energy from an energy storage device into the weakly-ionized plasma to enhance the rapid increase in electron density and the formation of a strongly-ionized plasma (Figure 6, element C1).

As to claims 34 and 44, Kouznetsov discloses a method wherein the magnitude of the first peak voltage is less than 1000 V (Figure 1, column 5, lines 42-44; since second peak voltage can be in the range of hundreds of volts, and the first peak voltage is lower in magnitude than the second peak voltage, consequently first peak can also be below 1000 V).

As to claim 36 and 45, Kouznetsov discloses a method wherein the magnitude of the second voltage is less than about 1000 V over the first voltage (Figure 1; column 5, lines 42-44).

As to claims 38 and 47, Kouznetsov discloses a method and apparatus for generating a strongly-ionized plasma, comprising: supplying feed gas proximate to an anode and a cathode assembly (column 10, lines 38-40, and as shown in figure 2, i.e. place where discharge is created); and applying a voltage pulse between the anode and the cathode assembly (Figure 2, indicated as "+" and "-" signs), the voltage pulse

comprising: a first peak voltage having a magnitude and a rise time that is sufficient to ignite an initial plasma from the feed gas; and a second peak voltage having a magnitude and a rise time that is sufficient to shift an electron energy distribution in the initial plasma to higher energies that increase an ionization rate resulting in a rapid increase in electron density and a formation of the strongly-ionized plasma (as shown in Figure 1) that is sustained for greater than 200 microseconds (column 10, lines 47-49).

As to claims 2, 22 and 39, Kouznetsov discloses the plasma generator further comprising a magnet (Figure 2, element 17) that generates a magnetic field proximate to the cathode assembly (as shown in figure 2, element 23 and 9).

As to claims 5, 24 and 41, Kouznetsov discloses the plasma generator wherein the magnetic filed (Figure 2, B-field) generated by the magnet (Figure 2, element 17) and an electric field generated by the multi-stage voltage pulse (Figure 2, element 18) induces an electron Hall current (it is an inherent result when E and H fields cross each other at 90 degrees angle) that raises the temperature (it is inherent that flowing current will rise the temperature) of the electrons in the weakly-ionized plasma to a temperature that enhances the rapid increase in electron density (temperature is an energy, and energy caused ionization among electrons contained in the gas) and the formation of the strongly-ionized plasma.

As to claim 42, Kouznetsov discloses the method wherein the voltage pulse further comprises a substantially constant voltage that sustains the strongly ionized plasma (Figure 1, S8).

As to claim 43, Kouznetsov discloses the method wherein duration of the voltage pulse is greater than 200 microseconds (column 10, lines 47-49).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov (US Patent 6296742) in the view of Fairbairn et al (US Patent 5844195). Kouznetsov teaches all the limitations taught in claim 1, however he does not teach that the feed gas comprises at least one of excited and metastable atoms. Fairbairn teaches a remote plasma source wherein already excited gas is injected into the chamber (column 2, lines 35-38). It would have been obvious to one of the ordinary skill in the art during the time the invention was made, to use Fairbairn teaching about injecting already (at least partially) excited gas, in the plasma generator taught by Kouznetsov because if injected gas is already partially excited it is easier to create plasma, since part of the gas is already a plasma, consequently it saves the time needed to generate plasma.

5. Claims 23 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov (US Patent 6296742) in the view of Somekh et al (US Publication 2005/0173239). Kouznetsov teaches all the limitations disclosed in claims 22 and 39

respectively, however he does not teach the method further comprising moving the magnetic field. Somekh teaches plasma sputtering apparatus wherein magnetron is rotated in order to achieve full coverage in sputtering of the target. It would have been obvious to one of the ordinary skill in the art during the time the invention was made to include the step of moving magnets as taught by Somekh in the method for sputtering as taught by Kouznetsov because as Somekh teaches rotating the magnets allows for full coverage in sputtering of the target, so the deposition of the particles on the wafer can be more uniform.

Claims 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov (US Patent 6296742) in the view of Lin et al (Chinese journal of physics, Bifurcation and Chaos in Weakly Ionized Magneto-Plasmas).

As to claim 29, Kouznetsov teaches all the limitations disclosed in claim 21, however he does not teach that the weakly-ionized plasma is in a steady state condition before the application of the second voltage. Lin teaches weakly ionized plasma being in a steady state (page 348, second paragraph). It would have been obvious to one of the ordinary skill in the art during the time the invention was made to use Lin's teaching about having weakly ionized plasma in a steady state, in Kouznetsov's sputtering apparatus because stable state occurs within finite range of the control parameters (page 348, paragraph 2), so that plasma can be easily controlled, i.e. once certain power is provided to the system, predictable events take place. It is important to note that in the process of sputtering control is very critical issue, since it allows to control how much material is deposited on the surface of the wafer.

As to claim 30, Kouznetsov teaches all the limitations disclosed in claim 21, however he does not teach that the weakly-ionized plasma is in a quasi-steady state condition before the application of the second voltage. Lin teaches weakly ionized plasma being in a quasi-steady state (page 351, paragraph 1). It would have been obvious to one of the ordinary skill in the art during the time the invention was made to make a use of Lin's teaching about controlling quasi-steady state of weakly ionized plasma, in the sputtering apparatus taught by Kouznetsov because as Lin describes in his article, a quasi steady state can be still controlled by applying certain power or voltages into the system, and in the process of sputtering, control is very critical issue, since it allows to control how much material is deposited on the surface of the wafer.

Allowable Subject Matter

6. Claims 10,14,15,32,33,37 and 46 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

As to claims 10 and 37, the prior art fails to teach the plasma generator as disclosed in claims 1 and 21 respectively, wherein the weakly-ionized plasma has discharge current density that is less than about 0.5 A/cm^2 and a power density that is less than about 250W/cm^2.

As to claim 14, the prior art fails to teach the plasma generator as disclosed in claim 1, wherein the second peak voltage in the transient stage forms ionizational instabilities in the weakly-ionized plasma.

As to claims 15 and 33, the prior art fails to teach the plasma generator as disclosed in claims 1 and 32 respectively, wherein the transient stage generates diocotron oscillations in the weakly-ionized plasma.

As to claim 32 and 46, the prior art fails to teach the method of generating strongly-ionized plasma as disclosed in claims 21 and 38 respectively, wherein the magnitude and the rise time of the second voltage are sufficient to generate ionizational instabilities in the weakly-ionized plasma that enhance the ionization rate resulting in a rapid increase in electron density and the formation of the strongly-ionized plasma.

The Prior Art

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- US 20040082187 discloses high power pulsed magnetically enhanced plasma processing
- US 6254745 discloses ionized physical vapor deposition method and apparatus with magnetic bucket and concentric plasma and material source
- US 6197165 discloses the method and apparatus for ionized physical vapor deposition.

Inquiry

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Angela M. Lie whose telephone number is 571-272-8445. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Don Wong can be reached on 571-272-1834. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Angela M Lie

TUYET VO
PRIMARY EXAMINER